Operating Properly and Successfully Demonstration and Interim Remedial Action Completion Report

For

Southern Flight Test Area of Operable Unit 1

Naval Weapons Industrial Reserve Plant
Bedford, Massachusetts

Naval Facilities Engineering Command
Mid-Atlantic

Contract No. N62470-08-D-1001
Contract Task Order No. WE45

October 2015

W5214887F

OPERATING PROPERLY AND SUCCESSFULLY DEMONSTRATION AND INTERIM REMEDIAL ACTION COMPLETION REPORT

FOR

SOUTHERN FLIGHT TEST AREA OF OPERABLE UNIT 1

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BEDFORD, MASSACHUSETTS

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Contract No. N62470-08-D-1001
Contract Task Order WE45

October 2015

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The Remedial Action for the Southern Flight Test Area has been implemented in accordance with the Explanation of Significant Differences (ESD) to the Site 3 Record of Decision at the Naval Weapons Industrial Reserve Plant in Bedford, Massachusetts. The remedy (monitored natural attenuation and land use controls) has been implemented as intended by the ESD/Record of Decision. The remedy is expected to achieve the Remedial Action Objectives, and until groundwater cleanup levels are met, land use controls are protecting human health and the environment by controlling site use and preventing exposure to contaminants associated with site groundwater.

Approval:

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Date: 11/02/2015

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LIST OF ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	contaminant of concern
CTO	Contract Task Order
CVOC	chlorinated volatile organic compound
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DOC	dissolved organic carbon
DOD	Department of Defense
ECP	Environmental Condition of Property
ERA	ecological risk assessment
ESD	Explanation of Significant Differences
FFA	Federal Facility Agreement
FS	Feasibility Study
IAS	Initial Assessment Study
I-RACR	Interim Remedial Action Completion Report
J	estimated quantity (when applied to sampling data)
LUC	Land Use Control
LUC RD	Land Use Control Remedial Design
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCP	Massachusetts Contingency Plan
mg/L	milligram(s) per liter
MNA	monitored natural attenuation
MOU	Memorandum of Understanding
mV	millivolt(s)
MW	monitoring well
NAVFAC	Naval Facilities Engineering Command
Navy	U.S. Department of Navy
NPL	National Priorities List
NWIRP	Naval Weapons Industrial Reserve Plant
OPS	Operating Properly and Successfully
ORP	oxidation-reduction potential
OU	Operable Unit
PAL	project action level
PFC	Perfluorinated compound
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonate
RACR	Remedial Action Completion Report
RAO	Remedial Action Objective
RI	Remedial Investigation
ROD	Record of Decision
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SFTA	Southern Flight Test Area
TCE	trichloroethene
U	not detected (when applied to sampling data)
USEPA	U.S. Environmental Protection Agency
VI	vapor intrusion
µg/L	microgram(s) per liter
µg/m^3	microgram(s) per cubic meter

1.0 INTRODUCTION

Operable Unit 1 (OU-1) at the Naval Weapons Industrial Reserve Plant (NWIRP) in Bedford, Massachusetts is comprised of Site 3 (the Chlorinated Solvent Groundwater Plume) and the Southern Flight Test Area (SFTA). This Operating Properly and Successfully (OPS) Demonstration / Interim Remedial Action Completion Report (I-RACR) has been prepared by Tetra Tech, Inc. (Tetra Tech) to demonstrate that the remedial action at the SFTA portion of OU-1 has been fully implemented and is currently operating as intended. An OPS/I-RACR for the Site 3 portion of OU-1 will be prepared under separate cover.

This report was prepared for the Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Contract No. N62470-08-D-1001, Contract Task Order (CTO) WE45. This report has been prepared as a precondition to deed transfer of the SFTA property, and meets U.S. Environmental Protection Agency (USEPA) guidance on OPS demonstrations (USEPA, 1996) and joint Department of Defense (DoD) and USEPA (2005) guidance for Remedial Action Completion Reports (RACRs).

A review was conducted of the ongoing remedial action for the SFTA, which includes monitored natural attenuation (MNA) of contaminants of concern (COCs) in groundwater, and land use controls (LUCs). The details of the remedial action selected for the SFTA are documented in an Explanation of Significant Differences (ESD) document which is a modification to the Site 3 Record of Decision (ROD) at NWIRP Bedford (U.S. Navy, 2014a). A site map of NWIRP Bedford showing the location of Site 3 and the SFTA is included as Figure 1.

This report consists of the following sections:

- Section 1.0 discusses the purpose of the OPS/I-RACR, and provides a brief summary of the site history and a chronology of events at the SFTA.

- Section 2.0 identifies the Remedial Action Objectives (RAOs) and remediation goals specified in the ESD/ROD for the SFTA.

- Section 3.0 summarizes the selected remedial action taken to meet the RAOs for the SFTA.

- Section 4.0 presents the OPS demonstration and I-RACR demonstration of completion to show attainment of the RAOs. It includes an evaluation of the approved natural attenuation remedy; provides information on COC concentration trends and monitoring; evaluates the LUCs; and

addresses risk to public health and environment, enforceability of the remedy, technology reliability, and the quality of the site characterization.

- Section 5.0 describes the ongoing environmental restoration activities at the SFTA.

- Section 6.0 summarizes the Navy's public outreach activities conducted for the SFTA.

- Section 7.0 summarizes the overall findings and conclusions of the OPS/I-RACR indicating that RAOs have been met and that the site is on track to achieve the target cleanup goals within a reasonable timeframe.

1.1 PURPOSE OF THE OPS DEMONSTRATION/I-RACR

NWIRP Bedford is a former research and development facility owned by the U.S. Navy, and has been vacant since 2000. The Navy is working to transfer the property for beneficial reuse, and is also currently addressing groundwater contamination at the SFTA (the southern portion of NWIRP Bedford) in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the National Priorities List (NPL). Pursuant to CERCLA Section 120(h)(3)(A)(ii)(I), a federal entity can seek to transfer federal property on which CERCLA hazardous substances have been released, disposed or stored, if it can covenant in the transfer deed that "all remedial action necessary to protect human health and the environment with respect to any substance remaining on the property has been taken before the date of such transfer." All necessary remedial action can be deemed to have been taken, and property can be transferred prior to completion of a remedial action, if "the construction and installation of an approved remedial design has been completed, and the remedy has been demonstrated to the Administrator to be operating properly and successfully" (CERCLA §120[h][3][B]). Thus, the purpose of the OPS Demonstration is to document that the selected remedial action is operating as intended. Similarly, a RACR is a means to document that remedial actions have been completed at DoD facilities listed on the NPL. As remedial actions are ongoing at the SFTA, this interim RACR (I-RACR) has been prepared to demonstrate that the remedy is in place and is operating successfully.

This OPS/I-RACR will assist the Navy, USEPA, and the Massachusetts Department of Environmental Protection (MassDEP) in making a professional judgment about the current status and expected future performance of the remedial action that has been implemented at the SFTA.

An OPS Demonstration involves two separate concepts:

1. A remedial action is operating *properly* if it is operating as designed; and

2. A remedial action is operating *successfully* when its operation indicates that it can achieve the cleanup levels or performance goals for the specified COCs as identified in the ROD (or, as in this case, in the ESD) and it is protective of human health and the environment (USEPA, 1996).

This OPS Demonstration will also provide USEPA with the necessary information required to prove that the institutional controls at the SFTA will be effective in preventing human or environmental exposure to hazardous substances that remain on site above levels which allow unrestricted use, and will perform as expected, as required in the USEPA guidance, *"Institutional Controls and Transfer of Real Property under CERCLA Section 120(h)(3)(A),(B), or (C)."*

Similarly, the I-RACR supports the determination that the remedy is in place, and that long-term RAOs can be met in the future. A final RACR will be prepared once all cleanup goals have been achieved. Separate OPS/RACR documents will be prepared for the other NPL operable units at NWIRP Bedford.

1.2 OVERVIEW OF SFTA

This section is intended to provide a brief discussion of the site characteristics, COCs, major findings, and results of past site investigation activities.

The 46-acre NWIRP Bedford facility is owned by the U.S. Government (Navy) and was operated by the Raytheon Company of Waltham, Massachusetts (Raytheon) from the mid-1950s until 2000. The property has been vacant since December 2000. The SFTA is located in the southern portion of NWIRP Bedford (south of Hartwell Road) adjacent to the Lawrence G. Hanscom Field and Hanscom Air Force Base (Figure 1). The mission of NWIRP Bedford was to design, fabricate, and test prototype equipment for missile guidance and control systems. Facilities at the SFTA were used to support this mission and included a former hangar, the Flight Test Facility, and a former plating laboratory, among other buildings. While the former Flight Test Facility is still present, most of the other buildings at the SFTA have been decommissioned and demolished since 2000. A list of key SFTA historical events and relevant dates in the site chronology are shown in Table 1.

Site Characterization

The Navy began environmental investigations at NWIRP Bedford in the late 1980s with several studies that included analysis of soil, groundwater, soil gas, sediment, and surface water. Environmental investigations were conducted at the SFTA as part of the overall Phase I Remedial Investigation (RI) and Phase II RI for NWIRP Bedford, as well as in various supplemental investigations. The results of these

investigations indicated that groundwater in the southern portion of the SFTA contains chlorinated volatile organic compounds (CVOCs), predominantly trichloroethene (TCE), at concentrations exceeding federal and state criteria (i.e., federal Maximum Contaminant Levels [MCLs] for drinking water and Massachusetts Contingency Plan [MCP] Method 1 GW-1 and/or GW-2 standards for groundwater). Although groundwater in this area is not used as a potable water source, the aquifer has been designated as an Aquifer Protection District by the Town of Bedford, as a potential source of municipal water supply.

The original source of the SFTA's groundwater contamination is uncertain; however, no remaining source of TCE has been found at the SFTA. No dense non-aqueous phase liquid (DNAPL) has been found, nor is it believed to be present based on the detected concentrations of CVOCs. No significant soil contamination was identified at the SFTA, and no unacceptable risks associated with analytes in soil were identified for current or likely future site use scenarios (commercial/industrial). To date, the potential risks associated with exposure to site soil for hypothetical future residents has not been evaluated; thus, the ESD includes a LUC to prevent residential redevelopment of the SFTA, pending further risk evaluations[1]. No unacceptable risks were associated with SFTA sediment or surface water exposures.

Since 2002, the Navy has been conducting a semi-annual groundwater monitoring program at the SFTA, with a focus on the identified COC, TCE, and its degradation by-products, cis-1,2-dichloroethene (cis-1,2-DCE) and trans-1,2-DCE. The highest concentration of TCE detected at the SFTA in the past, 250 micrograms per liter (µg/L) in the shallow bedrock aquifer at monitoring well MW-24R, was located in the central/southern portion of the SFTA. TCE concentrations at this and other SFTA locations have decreased substantially over time, with the current maximum being 35 µg/L, as detected in MW-24R in April 2015 (Sovereign, 2015). Currently, only TCE exceeds federal and state criteria, only in bedrock groundwater, and only in the south-central portion of the SFTA. Based on the sampling data from the semi-annual monitoring program, only three monitoring wells in this area currently have TCE concentrations greater than the target remediation goal of 5 µg/L (Figure 2, Table 2).

As discussed in more detail in Section 4, the decreases in TCE concentrations are likely due to a combination of natural attenuation processes and the effects of a groundwater extraction system located to the east of the SFTA, operated by the Air Force to address a separate area of groundwater contamination. The Air Force's groundwater remediation system at the adjacent Hanscom Field (former Hanscom Air Force Base) has been operating since 1991 and likely influences the direction and the velocity of groundwater flow at the SFTA. Groundwater flow in bedrock is toward the southeast, toward

[1] During the RI, the human health risk assessment did not evaluate the exposure of site soil to hypothetical future residents (i.e., if the site were to be redeveloped for residential use). Subsequent/preliminary risk evaluations suggest that chromium levels in soil could pose an unacceptable risk to onsite residents if it is present in the form of hexavalent chromium. However, only total chromium data are currently available. The Navy is conducting additional sampling in 2015 to determine the actual chromium speciation in soil. It is anticipated that the chromium is not hexavalent and, thus, this specific LUC would be deleted. No unacceptable risks are associated with soil and commercial/industrial uses of the site.

the airfield. The extraction system has been in place since shortly after the SFTA contamination was identified, and is believed to be capturing groundwater that flows from the SFTA site. In 2008, the Navy and the Air Force signed a Memorandum of Understanding (MOU) to ensure continued groundwater monitoring and sharing of information for the SFTA and Air Force sites.

Potential risks from vapor intrusion of CVOCs in soil gas were evaluated during the RI and the supplemental sampling event of February 2013. The risk evaluation of the 2013 soil gas data collected from the area of highest groundwater contamination indicated that there are no unacceptable risks associated with vapor intrusion of TCE from SFTA groundwater to indoor air (Tetra Tech, 2013a, 2013b).

During 2014-2015, the Navy conducted supplemental groundwater sampling events at the SFTA to evaluate the presence/absence of perfluorinated compounds (PFCs) and 1,4-dioxane, which are considered to be "emerging contaminants" by regulatory agencies. In December 2014, groundwater was tested for the PFCs perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) due to the former operation of aircraft hangars on the SFTA, and the historic firefighter training operations conducted at the adjoining former Hanscom Air Force Base property (Resolution, 2015a). None of the resulting PFOA or PFOS concentrations exceeded USEPA's Provisional Health Advisory (PHA); therefore, no further action regarding PFCs is required at the SFTA. In May 2015, groundwater at the SFTA was tested for 1,4-dioxane, as it can be a constituent of other chlorinated solvents detected in OU-1 groundwater. 1,4-dioxane was not detected in the groundwater samples; therefore, no further action regarding 1,4-dioxane is required at the SFTA (Resolution, 2015b). A summary of the emerging contaminant data is presented in Exhibit 1.

Exhibit 1

Summary of Groundwater Sample Results for Emerging Contaminants

SFTA Monitoring Well	PFOA (µg/L) PHA=0.4 µg/L	PFOS (µg/L) PHA=0.2 µg/L	1,4-dioxane (µg/L) ORSG=0.3 µg/L
MW-8B	0.017 U	0.0047 J	0.1 UJ
MW-8S	0.018 U	0.0234	0.1 UJ
MW-23R	0.018 U	0.0091 U	0.1 UJ
MW-23S	0.017 U	0.00871 J	0.1 UJ
MW-24R	0.0123 J	0.0174	0.1 UJ
MW-24S	0.017 U	0.0104	0.1 UJ
MW-25R	0.0494 J	0.118	0.1 UJ
MW-25S	0.017 U	0.0055 J	0.1 UJ

Note: Draft data.
PHA = Provisional Health Advisory
ORSG = MassDEP Office of Research and Standard Guideline
U = not detected at the cited concentration
J = estimated

2.0 RECORD OF DECISION AND REMEDIAL ACTION OBJECTIVES

In September 2010, the Navy and EPA (with concurrence from MassDEP) signed the ROD for Site 3 documenting the decision to address the groundwater CVOC plume using a combination of in-situ and ex-situ treatment, MNA, and LUCs. The COCs in Site 3 groundwater include TCE and other similar related CVOCs. The Navy's environmental investigations have shown that TCE is also present in bedrock groundwater at the SFTA, albeit at lower concentrations than at Site 3. As summarized in Section 1, the Navy has been conducting groundwater sampling at the SFTA, in accordance with the FFA and MOU, although it was not an official Area of Concern at NWIRP Bedford. In 2014, the Navy and USEPA signed an ESD that incorporates the SFTA into the Site 3 operable unit in order to provide an enforceable decision document that can support the planned transfer of the SFTA property. The SFTA was incorporated into OU-1 due to the similarities between contaminants (i.e., CVOCs) and between some of the components of the remedial actions (i.e., MNA and LUCs).

RAOs are medium-specific goals that define the objectives of conducting remedial actions to protect human health and the environment. RAOs specify the COCs, potential exposure routes and receptors, and acceptable concentrations (i.e., "remediation goals" or "cleanup levels") for a site and provide a general description of what the cleanup will accomplish. The ROD establishes the following RAOs for Site 3:

- Mitigate the identified unacceptable risks to human health associated with the use of Site 3 groundwater as a drinking water supply by reducing the concentrations of COCs[2] in groundwater to cleanup levels.

- Prevent the use of on-site groundwater for human consumption until groundwater cleanup levels have been achieved on site.

- Prevent the migration of COCs in groundwater at concentrations greater than cleanup levels.

In accordance with the ESD, the remedial action for the SFTA will also meet these RAOs (see Section 3). The ROD establishes the remediation goals for groundwater as the more stringent standards of the federal and state drinking water MCLs and Maximum Contaminant Level Goals (MCLGs). The same remediation goal will be used for TCE at the SFTA (i.e., 5 µg/L) in order to meet the objective of restoring groundwater quality for beneficial use.

[2] The ROD identifies the Site 3 COCs as 1,1-dichloroethene, 1,1-dichloroethane, 1,2-dichloroethane, cis-1,2-DCE, 1,1,2-trichloroethane, tetrachloroethene, TCE, and vinyl chloride. The ESD identifies the SFTA COC as TCE.

3.0 REMEDIAL ACTION

The remedial action for the SFTA is documented in the ESD to the Site 3 ROD (U.S Navy, 2014). The SFTA was incorporated into the Site 3 operable unit due to the similarity of contaminants and the components of the remedial actions. The selected remedy satisfies the RAOs described in Section 2 of this report.

The selected remedial action at Site 3 includes the following components:

- In-situ enhanced bioremediation of the source area (commenced in 2012)
- Downgradient groundwater extraction and ex-situ treatment for plume capture and control (commenced in 1997)
- MNA/Long-Term Monitoring (LTM) (ongoing monitoring program)
- LUCs (implemented to prevent the use of site groundwater, residential use of the site, occupancy of site structures, and to ensure continued maintenance of the remediation systems)
- Five-Year Reviews

Per the ESD, the remedial action for the SFTA does not include the first two components identified for Site 3 because no remaining source area has been identified at the SFTA and the groundwater is not adversely impacting downgradient areas. At the SFTA, the ongoing natural attenuation of the residual TCE combined with the effects of the groundwater extraction system to the east of the SFTA, operated by the Air Force to address a separate area of groundwater contamination, will prevent migration of the TCE plume. The Air Force's groundwater remediation system at the adjacent Hanscom Field likely influences the direction and the velocity of groundwater flow at the SFTA. The extraction system is believed to be capturing groundwater that flows from the SFTA site. The remedial action ensures the continued monitoring, control, and oversight of the SFTA cleanup under CERCLA. In the event that the Air Force significantly changes or discontinues the adjacent groundwater remediation system, the Navy's monitoring program will evaluate the potential changes to the groundwater flow direction and velocity at the SFTA and whether or not MNA will remain effective for achieving remediation goals within a reasonable timeframe. If it determined that contaminant concentrations are no longer attenuating at an acceptable rate, then the Navy, EPA, and MassDEP would reconvene to discuss whether additional actions are necessary for the protection of human health and the environment.

The components of the Site 3 remedy that have been incorporated into the SFTA remedial action are summarized below.

Monitored Natural Attenuation

MNA is being implemented in accordance with the Office of Solid Waste and Emergency Response (OSWER) Directive titled, "*Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites"* (USEPA, 1999b) and other MNA guidance documents. Under natural attenuation, naturally occurring processes in groundwater act without human intervention to reduce the mass, toxicity, volume, or concentration of COCs. When implementing MNA, periodic monitoring and technical evaluations are performed to ensure that COC concentrations are decreasing at an acceptable rate.

The scope of the MNA monitoring program (e.g., sampling frequency, number of locations, and list of analytes) is provided in the SAP (H&S Environmental and Tetra Tech, 2014). The SAP may be adjusted/optimized over time in response to the observed data trends. Semi-annual sampling of the bedrock groundwater monitoring well network at the SFTA will continue until remediation goals are achieved. Parameters being analyzed in groundwater include COCs and geochemical indicator parameters such as:

- TCE and its degradation byproducts (e.g., DCE and vinyl chloride)
- Dissolved oxygen, carbon dioxide, hydrogen, methane, ethane, and ethene
- Nitrate and nitrite, total and ferrous iron, sulfate and sulfide, chloride, alkalinity, and dissolved organic carbon
- Temperature, pH, oxidation/reduction potential, and conductivity

The MNA/LTM program satisfies the RAO to mitigate the unacceptable risks to human health by reducing COC concentrations in groundwater. Natural attenuation processes also work to prevent the migration of COCs in groundwater at concentrations greater than the remediation goals.

Land Use Controls

The Navy has implemented LUCs (institutional controls) to prevent exposure to COCs in groundwater and to protect human health during the interim time period until remedial actions have achieved RAOs across the site. The LUCs are established in the approved LUC RD (Navy, 2015) and cover the property parcels for Site 3 and the SFTA, as shown in Figure 3. The LUCs implemented as part of the remedial action for the SFTA portion of OU-1 include the following:

- Prevent use of SFTA groundwater as a drinking water supply until TCE concentrations in groundwater achieve the remediation goal (5 µg/L).

- Prevent residential development of the SFTA area until it is demonstrated that soil[3] and groundwater conditions allow for unlimited use and unrestricted exposure.

- Maintain the integrity of groundwater monitoring wells at the SFTA.

The LUCs satisfy the RAO to prevent the use of groundwater for human consumption until COC concentrations meet remediation goals. The Navy will maintain these LUCs at the SFTA until the concentrations of hazardous substances have been reduced to levels that allow for unlimited exposure and unrestricted use, as determined through the LTM program and five-year reviews. Compliance with the LUCs is ensured through annual inspections and reporting by the Navy to USEPA and MassDEP.

Five-Year Reviews

Five-year reviews will be conducted by the Navy in conjunction with USEPA and MassDEP, until groundwater conditions are restored such that the site is suitable for unrestricted use and unlimited exposure, in accordance with CERCLA. During such reviews, the Navy, USEPA, and state will review site conditions and monitoring data to determine whether the continued implementation of the remedy is appropriate. The Navy completed the first five-year review in 2014 (Resolution, 2014).

[3] During the RI, the human health risk assessment did not evaluate the exposure of site soil to hypothetical future residents (i.e., if the site were to be redeveloped for residential use). Subsequent/preliminary risk evaluations suggest that chromium levels in soil could pose an unacceptable risk to onsite residents if it is present in the form of hexavalent chromium. However, only total chromium data are currently available. The Navy is conducting additional sampling to determine the actual chromium speciation in soil. It is anticipated that the chromium is not hexavalent and, thus, this specific LUC would be deleted. No unacceptable risks are associated with soil and commercial/industrial uses of the site.

4.0 OPS DEMONSTRATION AND I-RACR DEMONSTRATION OF COMPLETION

This OPS/I-RACR demonstration was prepared for the SFTA groundwater remedy, which includes MNA, LUCs, and five-year reviews. For MNA sites, USEPA has identified the two core criteria and several additional criteria that must be addressed as part of an OPS demonstration (USEPA, 1996). The core criteria are as follows:

- Construction of the source control portion of the remedy is complete (or the source has been removed) in accordance with the approved design.

- Monitoring information shows that natural attenuation is working.

The first criterion is not directly applicable to the SFTA because no source area has been found at the site, as demonstrated in multiple investigations performed for site characterization. Based on the residual low concentrations of TCE in groundwater, no remaining source area is believed to be present on the SFTA property. Thus, the ESD for the SFTA does not include a source control remedial action. The approved remedial design for the SFTA includes the MNA SAP (H&S Environmental and Tetra Tech, 2014) and the LUC RD (Navy, 2015).

The second criterion is satisfied by the results of past and ongoing groundwater monitoring events at the SFTA. Items that support the demonstration that natural attenuation is working include: the documented reduction of COC concentrations; an established rate of COC loss; a plume that is stable or retreating; identification of intermediate degradation products in groundwater; changes in geochemical factors that indicate remediation is taking place; and confirmation by field data that indicate that attenuation of the plume will attain cleanup objectives within a reasonable timeframe.

Additional USEPA evaluation criteria include: confirmation that institutional controls/LUCs are in place; demonstration that the monitoring system has been completed in accordance with the approved design and is providing the data needed to evaluate the progress of natural attenuation; and an evaluation of potential surface water impacts. OPS demonstrations also include evaluations of the risk to public health and environment, enforceability, technology reliability, and site characterization.

The requirements for an I-RACR are similar, in that the demonstration should document that all construction activities are complete, the RAOs are being met, institutional controls are in place, and the site is protective of human health and the environment.

The sections that follow provide information demonstrating how the relevant OPS/I-RACR evaluation criteria are being met.

4.1 GROUNDWATER MONITORING AND NATURAL ATTENUATION

Construction of the monitoring well network is complete and it is operating as designed. The groundwater monitoring well network currently consists of eight bedrock wells and five overburden wells (Figure 4). Additional wells were available during past investigations, but were deemed to be "clean" (no exceedances of remediation goals) and are no longer needed for the monitoring program. The well network is being used to provide the necessary data to evaluate the performance of MNA at the SFTA. Groundwater samples are being collected and the results reported on a regular, semi-annual basis, in accordance with the approved SAP (H&S Environmental and Tetra Tech, 2012 and 2014). Potential modifications (optimizations) to the monitoring well network and monitoring program are evaluated on an annual basis as part of the Annual Report to USEPA and MassDEP for the NWIRP Bedford groundwater monitoring program.

TCE in bedrock groundwater is the only COC exceeding site remediation goals at the SFTA. Currently, the elevated concentrations of TCE are present in only three of the bedrock groundwater monitoring wells, located in the south-central portion of the SFTA (MW-8B, MW-24R, and MW84R) (Figure 2). TCE concentrations in groundwater have substantially decreased since first detected at the site in 1989. Beginning in 2013, the groundwater sampling events at the SFTA have included analyses for geochemical parameters associated with MNA. Multiple lines of evidence were considered to evaluate whether natural attenuation is occurring in bedrock groundwater at the SFTA. This included evaluations of temporal trends in COC concentrations to predict the timeframe for achieving cleanup goals, the presence of biodegradation by-products, and the geochemical conditions in the aquifer and their suitability for natural attenuation. The results are summarized below.

4.1.1 Trend Analysis of COC Concentrations

The goals of the trend analyses were to evaluate whether statistically significant trends in COC concentrations are occurring at the site over time. The overall trends in the groundwater COC data over time have been evaluated using graphical and statistical methods.

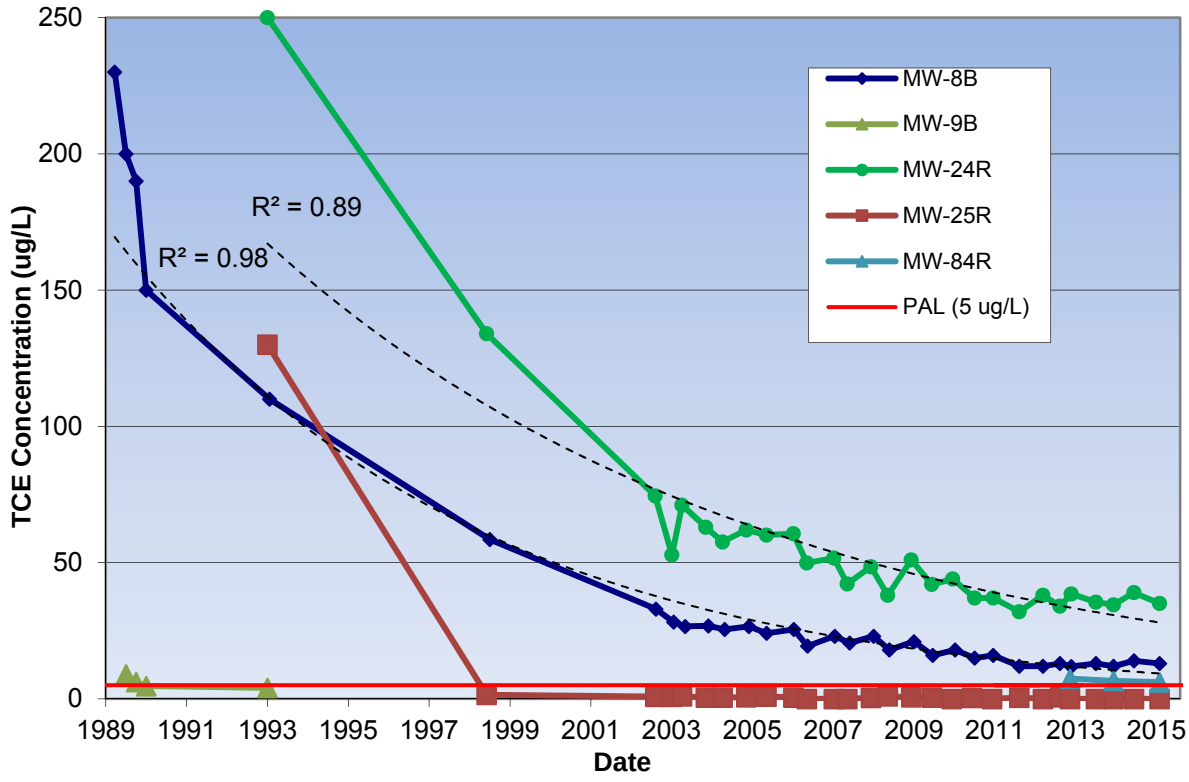
Graphical Trend Analysis

Table 2 summarizes the historical sampling results for TCE, cis-1,2-DCE, and trans-1,2-DCE at each of the bedrock monitoring wells at the SFTA. Trend graphs were developed for the wells where TCE has

been detected. As shown in Exhibit 2, TCE concentrations show an overall downward trend for monitoring wells MW-8B and MW-24R. The TCE concentration at MW-84R (6.1 µg/L) is close to achieving the remediation goal of 5 µg/L. TCE concentrations at MW-25R, located at the far eastern part of the property, have been consistently below 1 µg/L since the November 2002 sampling event, and initially dropped from 130 to 1.5 µg/L during the 1990s. Similarly, TCE concentrations at MW-9B, at the western part of the property, have been below the remediation goal since 1990. The reduction in TCE concentrations at the plume fringes (MW-8B, MW-9B, MW-25R) indicate that the extent of the plume is retreating over time.

Exhibit 2

Trend Graph of TCE Concentrations in Bedrock Groundwater



Trend graphs were not prepared for cis-1,2-DCE or trans-1,2-DCE because the majority of the results were trace or non-detect and do not exceed their respective project action limits (PALs), as shown in Table 2.

Data regression statistics were determined for MW-8B and MW-24R, where TCE concentrations exceed the remediation goal of 5 µg/L and sufficient temporal data are available for a trend analysis. Best-fit

(exponential) regression lines were plotted for the data sets, and correlation coefficients (R^2 values[4]) were calculated using Microsoft Excel as an indication of how well the data set fits the regression lines. Wells MW-8B and MW-24R continue to show a downward trend in those TCE concentrations, with strong correlations ($R^2 \geq 0.9$) to the best-fit regression lines, as shown in Exhibit 2. This indicates continued progress toward the cleanup goal.

Based on mathematical regressions of the TCE data set from the semi-annual monitoring program (2002 to 2015) for MW-8B and MW-24R, the projected timeframe to achieve cleanup goals in bedrock groundwater is approximately 20 years (Sovereign, 2015).

Statistical Trend Analysis

For the semi-annual groundwater sampling events, the guidance document "*Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities"* (USEPA, 1989) and the text "*Statistical Methods for Environmental Pollution Monitoring"* (Gilbert, 1987) were used to select the statistical approach to evaluate the data sets[5]. Although the USEPA guidance document was developed primarily to compare contaminant data to background levels at Resource Conservation and Recovery Act (RCRA) sites, some of the principles discussed in that guidance document can also be used to conduct general comparisons of groundwater data.

The Mann-Kendall statistical test was selected to evaluate trends in the TCE concentrations in bedrock groundwater at the SFTA. TCE was chosen as the representative COC for the statistical trend analysis conducted herein because: (1) the TCE concentrations were an order of magnitude higher than either cis-1,2-DCE or trans-1,2-DCE; (2) the TCE data set was more complete than those for cis-1,2-DCE or trans-1,2-DCE; and (3) only TCE exceeds the PALs/Remedial Goals. The Mann-Kendall test is considered well-suited to the data set because it can be used for data that are non-parametric (i.e., do not have a specific distribution, such as normal or log-normal), the data set can contain data at irregularly spaced intervals, and missing data points are allowed. In addition, data that are reported as below the detection limit or Practical Quantitation Limit (PQL) can be used, since the Mann-Kendall test uses only the relative magnitudes of the data for the comparison, not the measured values. The version of the Mann-Kendall test utilized in this analysis (Gilbert, 1987) is applicable to data sets containing 40 or fewer

[4] R^2 values represent the Coefficients of Determination (correlation coefficients) for the best-fit exponential regression lines (dashed lines) shown on Exhibit 2 and Exhibit 3. R^2 values can range from 0 to 1, where $R^2 = 1$ would represent a data set where there is no variation in the data from the best-fit regression line (i.e., a highly predictable trend) and $R^2 = 0$ would represent a data set where there is no correlation between the variables (in this case, representing the observed TCE concentration trend over time).

[5] MULTMK/PARTMK – a Visual Basic program for multivariate and conditional Mann-Kendall tests of monotone trends in time series of data grouped by sites, plots, and seasons – was used to run the Mann-Kendall analyses. The program was developed by Anders Grimvall, extended by Claudia Libiseller, Linköping University, in collaboration with the Swedish University of Agricultural Sciences, September 2003.

data points. As with many statistical tests, the validity of the results is increased when the sample size is larger; however, the test may be performed on as few as four values.

The Mann-Kendall test is performed as follows:

- Appropriate statistical significance levels (α) are chosen.
- The data are listed in the order in which they were collected.
- Each data point is compared to the points that follow in time.
- The number of times the data increase is compared to the number of times the data decrease.
- The greater the number of increases or decreases, the more evidence there is for an upward or downward trend.

The following guidelines were followed when applying the Mann-Kendall test to the SFTA bedrock groundwater data set:

- The TCE concentrations were evaluated for wells that were sampled at least four times. Results from field duplicate samples for a particular sampling event were averaged.

- TCE concentration values were rounded to two significant figures and TCE values less than 10 µg/L were rounded to the nearest whole integer, in order to be consistent with the degree of certainty in the analytical results.

- When TCE concentrations were non-detect in a sample, the concentration was assigned a value of zero. This approach is valid because the Mann-Kendall analysis compares the relative magnitude of numbers, not the actual values.

- The statistical evaluations were performed at both 99 and 95 percent confidence levels. A high significance level was selected in order to reduce the possibility of incorrectly identifying a trend (upward or downward), when no trend actually exists.

The Mann-Kendall trend analysis is not well-suited for data sets with many rounds of low or non-detect values. For example, 1 µg/L and 2 µg/L are essentially the same analytical result, but would be considered different numbers in the Mann-Kendall trend analysis. Accordingly, the data sets from MW-25R and MW-84R are not well-suited for the Mann-Kendall analyses due to the trace TCE concentrations observed over time or too few data points, as shown in Table 2. Therefore, the Mann-Kendall analyses were only performed for the data sets from MW-8B and MW-24R.

The Mann-Kendall analyses for MW-8B and MW-24R both exhibited statistically significant downward trends at the 99 percent confidence level ($p < 0.01$) for the overall data set since 1989 (Sovereign, 2015). No substantial differences in the data trends were found when the data were analyzed as a whole or when grouped according to sampling season (H&S Environmental and Tetra Tech, 2013).

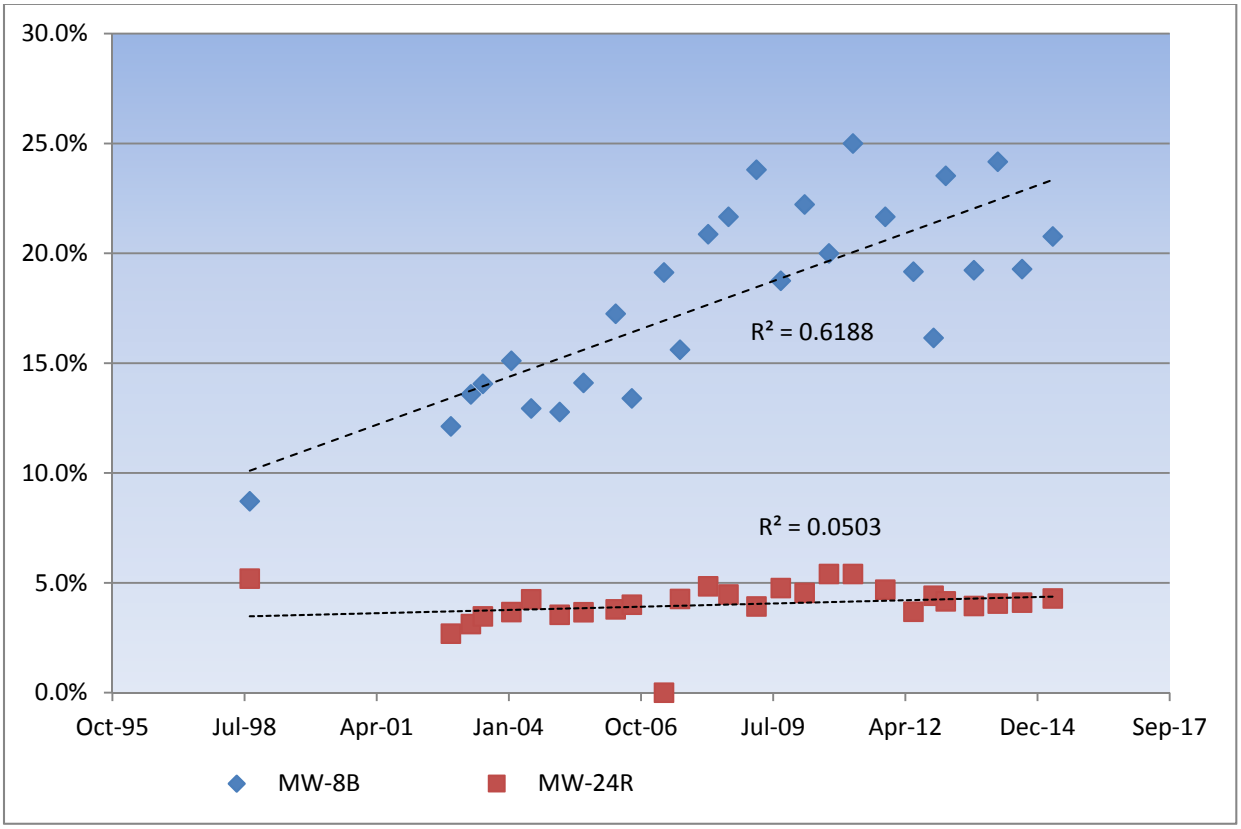
4.1.2 Chlorinated Ethene Degradation – Presence of By-Products

The primary by-product of the biodegradation of TCE (a chlorinated ethene compound) is cis-1,2-DCE. Less common by-products include trans-1,2-DCE and 1,1-DCE. Further degradation of DCE would result in the formation of vinyl chloride, and complete biodegradation would reduce vinyl chloride to ethene/ethane or carbon dioxide and chloride.

During the semi-annual sampling events at SFTA, groundwater samples were analyzed for TCE, cis-1,2-DCE, and trans-1,2-DCE. The analytical results are summarized in Table 2. In general, cis-1,2-DCE detections were co-located with TCE, suggesting some TCE degradation is occurring throughout the plume. The presence of cis-1,2-DCE rather than trans-1,2-DCE is consistent with biological degradation processes for TCE. As shown on Exhibit 3 below, the DCE to TCE ratios in MW-8B have also been increasing over time, indicating that some reductive dechlorination of TCE is occurring. The trace concentrations of DCE in MW-24R have remained relatively constant over time, although TCE concentrations have decreased in that well.

Exhibit 3

DCE to TCE Ratios over Time in Bedrock Groundwater



Although recent groundwater samples have not been analyzed for vinyl chloride, past monitoring events from 2002 to 2010 included the vinyl chloride analysis for bedrock wells. No vinyl chloride was detected in those wells during past monitoring events, suggesting that the TCE degradation process may be limited to DCE, perhaps due to the limited availability of dissolved carbon in bedrock groundwater that would support continued biodegradation processes. However, as noted in Section 4.1.1, the overall concentrations of TCE are continuing to attenuate toward cleanup goals, and concentrations of DCE remain below PALs. The following section provides further information regarding ethene, ethane, chloride, and dissolved organic carbon.

4.1.3 Water Quality/Geochemical Conditions

Table 3 summarizes the results for the MNA indicator parameters measured in groundwater during the February 2013 monitoring event[6].

[6] The February 2013 monitoring event included the most complete assessment of geochemical parameters in SFTA groundwater. The subsequent semi-annual groundwater monitoring events collected samples from fewer wells, but produced similar results.

Oxidation-Reduction Potential (ORP) and Dissolved Oxygen (DO)

CVOC degradation involves dechlorination of CVOC molecules under either anaerobic or aerobic conditions. Generally, dechlorination of TCE and DCE occurs under anaerobic (reducing) conditions and the resulting, less-chlorinated by-products (e.g., vinyl chloride) can be aerobically degraded. Evidence of strongly reducing conditions that are favorable for supporting anaerobic biodegradation of CVOCs include low ORP (typically less than -50 millivolts [mV]) in conjunction with low DO concentrations (typically less than 0.5 mg/L). ORP levels up to +50 mV may still allow for the reductive pathway to biodegrade CVOCs. During the February 2013 supplemental sampling event, the wells which had detected concentrations of TCE (i.e., MW-8B, 24R, 84R, 85R, and 86R) generally showed moderate reducing conditions with favorable DO levels (average DO of 0.35 mg/L), and slightly positive ORP levels which can still allow for degradation of CVOCs (average of +17.8 mV).

Ethene and Ethane

The presence of ethene and/or ethane would be indicative of completed reductive dechlorination of TCE. As summarized in Table 3, ethene and ethane were not detected in groundwater sampled during the February 2013 sampling event, which is consistent with the lack of any detected vinyl chloride during past sampling events, as noted in Section 4.1.2.

Chloride

Chloride is an end-product of CVOC degradation. Chloride concentrations exceeding background levels can be indicative of CVOC degradation[7]. At the SFTA upgradient well, MW-23R, the chloride concentration was 100 mg/L; whereas, the chloride concentrations at other SFTA wells ranged from 100 mg/L in MW-85R to 275 mg/L in MW-24R (average = 152 mg/L). Chloride concentrations were highest along the centerline of the plume (275 mg/L in MW-24R and 180 mg/L in MW-8B) which is consistent with the reductive dechlorination of CVOCs.

Ferrous Iron

Fe(II) concentrations over 1 mg/L may indicate that an iron-reducing bioremediation pathway is active. During the February 2013 sampling event, the Fe(II) results ranged from non-detect to a maximum of 0.435 mg/L. Although Fe(II) concentrations were below 1 mg/L, it is noted that the highest Fe(II)

[7] The presence of chloride in groundwater can also be a result of other factors such as pavement salting during winter months. It is the Navy's understanding that Hanscom Field does not use salt on the airport runways, taxiways, or adjacent areas. However, the Town salting of Hartwell Road may occur. The selected reference well (MW-23R) is located on the downgradient side of Hartwell Road.

concentration was found in MW-24R (the well with the highest TCE concentration), suggesting that some iron reduction of CVOCs may be occurring.

Nitrite and Nitrate

Nitrate concentrations less than 1 mg/L are generally desirable so as not to compete with CVOC reduction pathways (i.e., nitrate can act as a competing electron acceptor to CVOCs). As shown in Table 3, nitrate concentrations during the February 2013 groundwater sampling event were favorable (low to non-detect) in each of the samples except for the upgradient well, MW-23R (1.1 mg/L), where COC concentrations were non-detect. Nitrite was non-detect in the February 2013 groundwater samples.

Sulfide and Sulfate

Sulfate concentrations less than 20 mg/L are generally desirable so as not to compete with CVOC reduction pathways (i.e., sulfate can act as a competing electron acceptor to CVOCs), whereas sulfide concentrations greater than 1 mg/L may indicate conditions that are supportive of CVOC degradation. During the February 2013 sampling event, sulfate concentrations of 20 mg/L or higher were detected in five of the six sampled monitoring wells (83 percent), which is likely representative of background conditions, given that the sulfate concentration in upgradient well MW-23R was 35 J mg/L.

Sulfide was not detected in groundwater samples collected during the February 2013 supplemental sampling event.

Methane

The presence of methane can be an indicator of favorable reducing conditions for CVOC degradation. During the February 2013 sampling event, a low concentration of methane was detected in the sample from the well with the highest TCE concentration (9.6 µg/L of methane in MW-24R).

Dissolved Organic Carbon

Dissolved organic carbon (DOC) is a measure of the amount of carbon that is available for fermentation in order to yield the necessary hydrogen to support biodegradation of CVOCs. DOC values higher than 20 mg/L are generally desirable for driving reductive dechlorination, although other factors such as the form of the carbon (bioavailability), the amount of DOC influx into the area (replenishment), and the presence of other electron acceptors (competing for DOC usage) also play a role in the effectiveness of reductive dechlorination. During the February 2013 sampling event, DOC concentrations ranged from

1 mg/L (MW-23R) to 10.1 mg/L (MW-84R), indicating that a limited amount of carbon is available for fermentation by microbes in bedrock groundwater.

pH and Alkalinity

The pH in groundwater at each of the wells sampled during the February 2013 supplemental sampling event (average pH of 6.7) was within the desired pH range (pH between 5 and 9) for natural attenuation through biodegradation.

Complete mineralization of CVOCs would result in increased dissolved carbon dioxide concentrations in groundwater, which then may interact with aquifer minerals and increase the measured alkalinity levels. During the February 2013 sampling event, the observed alkalinity levels within the plume area (average of 80 mg/L) were similar to background levels observed in the upgradient monitoring wells.

4.1.4 Other Supporting MNA Evaluations

No microbial assays associated with MNA have been conducted for the SFTA groundwater; however, baseline microbial assays conducted in October 2012 at Site 3 (where bedrock aquifer conditions are similar) were reported to contain CVOC-reducing bacteria (Dehalococcoides spp.) counts ranging from non-detect to 3,060,000 cells/mL (AGVIQ/CH2M HILL, 2015).

4.1.5 Natural Attenuation Evaluation Summary and Conclusions

Based on the multiple lines of evidence approach discussed above, the available data indicate that natural attenuation is effectively contributing to the reduction of the residual TCE concentrations in bedrock groundwater. This is based on the suitability of groundwater geochemical conditions for natural attenuation to occur, the presence of biodegradation by-products, and evaluations of temporal trends in groundwater COC concentrations to predict the timeframe for achieving cleanup goals.

The overall water quality is generally favorable for biotic attenuation (reductive dechlorination) of TCE in bedrock groundwater. The DO levels are favorable (less than 0.5 mg/L) in the monitoring wells with TCE concentrations that exceed the remediation goal. The ORP levels were found to be slightly oxidizing (average of +17.8 mV), but are low enough that a reductive pathway to biodegrade CVOCs is still viable (i.e., less than +50 mV). The groundwater pH is within the desired range for natural attenuation through biodegradation. Concentrations of nitrate and nitrite were at favorable low levels so as not to compete with the preferred CVOC reduction pathways, although background levels of sulfate may compete

somewhat with the CVOC reduction pathways. Some DOC was detected in the groundwater samples, although the low levels of DOC (less than 20 mg/L) may act to slow the overall rate of attenuation.

An evaluation of degradation by-products indicates that biodegradation of TCE to cis-1,2-DCE is occurring. Concentrations of cis-1,2-DCE are remaining below the cleanup goals. Historical sampling data were non-detect for DCE's degradation by-product, vinyl chloride; however, concentrations of final end-products such as chloride and methane are highest at MW-24R (where TCE concentrations are highest). Similarly, increased (although low) concentrations of ferrous iron were detected within the plume area, suggesting that an iron-reducing bioremediation pathway for CVOCs may be active.

Most significant for the MNA evaluation are the trend data for COC concentrations in site monitoring wells. Trend graphs based on data from 1989 to 2014 show rather consistent, predictable decreases in wells MW8B, MW-24R, and MW-25R with statistical regression analyses and supplemented by additional data collection. The graphical analysis shows consistent downward trends in TCE concentrations. The downward trends are statistically significant at a 99 percent confidence level. Regression analyses indicate that remediation goals will be achieved in approximately 20 years.

4.2 LAND USE CONTROLS

To ensure protection of human health and the environment during the interim time until site restoration has been completed, the Navy has implemented specific LUCs at the SFTA. LUCs are one of the components of the selected CERCLA remedy for the SFTA groundwater contamination, as identified in the ESD (U.S. Navy, 2013). Currently, the site is unused and vacant, and the reasonably anticipated future land use at the SFTA is commercial/industrial. The USEPA Guidance Document, "*Institutional Controls and Transfer of Real Property Under CERCLA Section 120(h)(3)(A),(B), or (C)*", requires that the transferring federal agency demonstrate prior to transfer that certain procedures are in place, or will be put in place, to provide USEPA with a sufficient basis for determining that LUCs will perform as expected in the future.

LUCs were identified as one of the long-term remedy components in the ROD/ESD. The LUCs performance objectives identified in the ESD were formalized in an approved LUC RD (U.S. Navy, 2015). The LUCs for the SFTA, similar to those already existing for the adjacent Site 3, control property use and prevent exposure to the site COC. LUCs ensure that components of the remedy are not disturbed and meet the following LUC Performance Objectives for protecting human health and the environment at the SFTA:

- Prevent use of SFTA groundwater as a drinking water supply until TCE concentrations in groundwater achieve the cleanup goal.

- Prevent occupancy of current and future SFTA structures until it can be demonstrated that there are no unacceptable risks associated with vapor intrusion of TCE from SFTA groundwater to indoor air.

    - *Note: The Navy has satisfied this performance objective by conducting a vapor intrusion evaluation at the SFTA in 2013. The evaluation of soil gas samples collected from the site demonstrated that there are no unacceptable risks associated with vapor intrusion of TCE from SFTA groundwater to indoor air; therefore, in accordance with the Site 3 ROD and ESD, there is no requirement for a LUC that prevents occupancy of structures at the SFTA (Tetra Tech, 2013a, 2013b). EPA and MassDEP concur with this finding.*

- Prevent residential development of the SFTA area until it is demonstrated that soil[8] and groundwater conditions allow for unlimited use and unrestricted exposure.

- Maintain the integrity of groundwater monitoring wells at the SFTA.

The extent of the LUC boundaries for the SFTA and Site 3 are depicted on Figure 3. The LUC RD includes additional detailed information regarding the LUC objectives, LUC implementation actions, monitoring of LUCs, reporting procedures, LUC enforcement, and LUC modification/termination. The LUCs are enforceable under federal and state programs and will be maintained until concentrations of hazardous substances at the site have been reduced to levels that allow for unrestricted use and unlimited exposure, as determined by the site monitoring program.

To date, the following LUC implementation actions for the SFTA have been completed:

- Copies of the LUC RD have been provided to federal, state, and local regulatory agencies. A copy is also available as part of the NWIRP Bedford Administrative Record and the local Information Repository at the Town of Bedford Free Public Library.

- A map defining the LUC boundaries has been prepared as part of the LUC RD and has been provided to the Town of Bedford, USEPA, and MassDEP. The boundaries have also been

[8] During the RI, the human health risk assessment did not evaluate the exposure of site soil to hypothetical future residents (i.e., if the site were to be redeveloped for residential use). Subsequent/preliminary risk evaluations suggest that chromium levels in soil could pose an unacceptable risk to onsite residents if it is present in the form of hexavalent chromium. However, only total chromium data are currently available. The Navy is conducting additional sampling to determine the actual chromium speciation in soil. It is anticipated that the chromium is not hexavalent and, thus, this specific LUC would be deleted. No unacceptable risks are associated with soil and commercial/industrial uses of the site.

incorporated into the Navy's Geographic Information System (GIS) database and real estate summary map(s) for NWIRP Bedford.

- A program of annual LUC compliance monitoring and reporting has been initiated. The first annual monitoring inspection for NWIRP Bedford was conducted in September 2011. The annual inspections began including the SFTA property in September 2014 (Sovereign, 2014), due to the updated LUC RD. The annual LUC inspection reports have been provided to the USEPA, MassDEP, and the Town of Bedford Board of Health.

- The Navy is continuing to conduct a groundwater monitoring program at the SFTA. Data reports are provided to project stakeholders on a semi-annual basis (sampling events are typically conducted in March and September of each year).

- The Navy has notified USEPA and MassDEP of the planned transfer of the SFTA property. The Navy provided a letter of intent to USEPA and MassDEP on August 4, 2015.

Upon transfer of the SFTA property, the Navy will complete the following implementation actions for the SFTA:

- A copy of the executed deed or transfer documents will be provided to the USEPA and MassDEP.

- The Navy will continue to coordinate with the Town of Bedford Board of Health and monitor the Town's implementation of the municipal Code of Health Regulations which control the installation and use of private water wells. The Navy will also continue to coordinate with the Town to monitor any proposal to develop for residential use any of the privately owned property within the SFTA LUC Area.

- The Navy will continue to conduct LUC compliance monitoring and notification activities as outlined in the LUC RD.

The LUC restrictions are to be included in the Deed of transfer which will be drafted after an Environmental Condition of Property (ECP) report has been prepared. The LUCs for the SFTA shall be enforceable against future transferees of the property via the provisions to be contained in the Deed of conveyance for the property. The Navy is committed to ensuring that the LUCs that will be contained in that Deed will successfully be transferred to, and complied with by, the subsequent owner(s) of the SFTA property. As per the LUC RD, both the USEPA and MassDEP will have the opportunity to review and concur on any Navy determination to modify or terminate the LUCs in the future. The LUCs will be

maintained until the concentrations of hazardous substances in groundwater decrease to levels that allow for unrestricted use and unlimited exposure.

4.3 GENERAL CONSIDERATIONS

In addition to the core criteria analyzed above, the USEPA guidance identifies four factors that are to be considered for all remedies in an OPS demonstration: (1) risk to public health and environment (including any potential surface water impacts), (2) enforceability, (3) technology reliability, and (4) site characterization.

4.3.1 Risk to Public Health and the Environment

With the remedy in place at the SFTA (MNA, LUCs, and five-year reviews), concentrations are decreasing for the only COC (TCE) that remains in groundwater at levels above the remediation goal, and potential exposure to that COC is being prevented through the implemented LUCs, thereby preventing any unacceptable risks to public health and the environment. The SFTA is currently a vacant, industrial-use parcel and the reasonably anticipated future use is commercial/industrial. Groundwater at the site is not used as a drinking water source and does not adversely impact off-site areas. Therefore, there are no current or anticipated future exposures to site contamination (i.e., for commercial/industrial use) that could result in an unacceptable risk.

The established LUCs will remain in place at the site until the remediation goals have been achieved and the site is suitable for unlimited use and unrestricted exposure. The Navy is continuing its long-term groundwater monitoring program and its annual LUC inspection program, with appropriate reporting to federal, state, and local agencies. After the planned property transfer, the LUC RD will continue to be implemented by the Navy, and will be reinforced by deed restrictions requiring the Transferee and its successors or assigns to comply with the LUCs.

In accordance with CERCLA Section 121c, five-year reviews are required so long as hazardous substances, pollutants, or contaminants remain at levels that do not allow for unlimited use and unrestricted exposure. In 2014, the Navy completed the first five-year review for NWIRP Bedford in coordination with USEPA and MassDEP (Resolution, 2014). The next five-year review is planned to be completed in 2019.

During the RI, the ecological risk assessment identified no unacceptable risks for ecological receptors at NWIRP Bedford, and noted that potential ecological risks at the SFTA would be even lower than any associated with the overall NWIRP Bedford area because the majority of the SFTA is paved.

Approximately one-third of the SFTA area is covered by a concrete aircraft apron, one-third is paved or covered by the former SFTA building, and one-third is grass-covered (Figure 1). There are no expected impacts from the site to nearby surface water bodies. Surface runoff in the SFTA follows the paved surface topography and enters storm water catch basins that discharge to drainage ditches along Hanscom Field. Surface runoff also infiltrates into the grass surrounding the paved area or infiltrates through cracks in the pavement. No surface water bodies are present in the vicinity of the SFTA; Elm Brook is approximately one-half-mile to the northwest of the site, and the Shawsheen River is located more than a mile to the southeast of the site.

4.3.2 Enforceability

NWIRP Bedford was placed on the NPL in 1994, and the Navy and USEPA signed a FFA effective in 2000. The Navy, USEPA, and MassDEP have been continuously involved as the enforcement vehicle for continued action at the NWIRP Bedford sites, including the SFTA, and the work associated with remedial actions. The FFA provides the terms and conditions related to enforcement and dispute resolution related to the remedial actions at NWIRP Bedford. The remedial action for the SFTA has been approved by the Navy, USEPA, and MassDEP in an ESD to the Site 3 ROD (Navy, 2014), which is a USEPA-enforceable document under CERCLA. LUCs will be enforced through the LUC RD associated with the SFTA remedial action, and will be binding on future Transferees of the property. At the time the property is transferred, provisions requiring the new owners and successors or assigns to comply with the LUCs (to control property use and to prevent exposure to TCE via groundwater use) will be incorporated into the deed and other property transfer documents. The deed will also contain provisions which guarantee the Navy, USEPA, and MassDEP a right of access for conducting activities such as LTM, LUC inspections, five-year reviews, and any necessary remedial actions for the protection of human health and the environment. The Navy and/or regulatory agencies retain independent authority to undertake response actions under CERCLA and equivalent state legal authorities, or to otherwise enforce the restrictions contained in the deed. Together, these mechanisms ensure that the continued effectiveness of the remedy will not be compromised.

4.3.3 Technology Reliability

The components of the remedy in place at the SFTA (MNA, LUCs, and five-year reviews) have been shown to be successful at many CERCLA sites, for mitigating risks to human health and the environment associated with COCs such as TCE. The required technologies and services are readily available. The data collected from the groundwater monitoring program at the SFTA demonstrate that COC concentrations are decreasing at the site and are expected to achieve remediation goals within a reasonable timeframe. MNA/LTM reports, the annual LUC inspections, and the CERCLA Five-Year

Reviews will ensure that the any changes in the effectiveness of the remedy components will be identified and addressed, if necessary.

4.3.4 Effectiveness of Site Characterization

The SFTA was identified and investigated in conjunction with Phase I and II RIs conducted for NWIRP Bedford. The nature and extent of contamination at the SFTA, along with the geology, hydrogeology, surface features, and land use, were studied and documented under the RIs and various supplemental investigations, as summarized in Section 1 of this report. Pursuant to a recommendation in the Five-Year Review (Resolution, 2014), the supplemental investigations included sampling at the SFTA in 2014 and 2015 for the emerging contaminants PFCs and 1,4-dioxane.

These investigations indicate that only low-level, residual concentrations of TCE remain in bedrock groundwater in the south-central portion of the SFTA. No remaining source area has been identified on site. The Navy has been conducting semi-annual groundwater monitoring since 2002 in order to document the nature and extent of the contamination over time. COC concentrations in groundwater have shown a substantial decrease over time across the monitoring well network. LUCs are in place to address the remaining questions regarding the site characterization (e.g., soil exposure under a hypothetical future residential reuse scenario). The site characterization and conceptual site model will continue to be updated over time through the groundwater monitoring program and supplemental investigations, in order to ensure that the selected remedy remains effective for the SFTA.

5.0 ONGOING ACTIVITIES

The ongoing activities at the SFTA include:

- LUC Monitoring – The Navy conducts annual inspections of the site for compliance with the established LUCs. LUC inspection reports are provided to USEPA, MassDEP, and the Town of Bedford Board of Health. The most recent LUC inspection was completed in September 2015. Section 4.2 of this report identifies the implementation actions that will continue for LUC monitoring, in accordance with the LUC RD, to ensure that land uses at the site continue to be protective and that corrective actions, if needed, are taken. As described in Section 4.2, the Navy is conducting supplemental soil sampling in 2015, followed by a residential risk evaluation, to determine whether to keep or delete the LUC associated with soil exposure under a residential reuse scenario.

- MNA LTM – The Navy is conducting a program of semi-annual groundwater sampling in order to document the attenuation of COC concentrations in bedrock groundwater at the SFTA. The necessary monitoring well network is already in place. The most recent groundwater monitoring event was in September 2015. The next monitoring event is planned for March 2016.

- Five-Year Reviews – The Navy, in coordination with USEPA and MassDEP, completed the first Five-Year Review for NWIRP Bedford in September 2014 (Resolution, 2014). The next Review is planned to be conducted in 2019.

These activities will be conducted for as long as necessary until RAOs are met.

6.0 COMMUNITY RELATIONS

The Navy has been performing public participation activities in accordance with CERCLA and the NCP throughout the site cleanup process at NWIRP Bedford. A Community Relations Plan prepared by the Navy in 1992 outlined a program to address community concerns and keep citizens informed about and involved in remediation activities. The Navy has kept the community and other interested parties apprised of environmental investigation activities through informational meetings, fact sheets, press releases, and contact with local officials. Since March 1996, the Navy has also periodically met with the Restoration Advisory Board (RAB) to discuss the status and progress of the IR Program. RAB meetings are open to the public and are typically attended by representatives of the Navy, USEPA, and MassDEP, and by local government officials.

The Navy has developed an Administrative Record that is available for public review at the NAVFAC office in Norfolk, Virginia. A local Information Repository with a copy of the Administrative Record has also been established at the Bedford Free Public Library reference desk, 7 Mudge Way, Bedford, Massachusetts. The Administrative Record contains the documents and other relevant information that were relied on in the remedy selection process for CERCLA sites at NWIRP Bedford. The Administrative Record was made available on CD from 2004 to 2010, and NAVFAC is currently working to make these documents available to the public online. Copies of documents related to environmental sampling at the SFTA are also provided to the Air Force's environmental manager at Hanscom Field, in accordance with the MOU.

On August 6, 2013, a fact sheet describing the ESD to the ROD was issued to the NWIRP Bedford community mailing list in order to facilitate comment on the document. The Navy held a public meeting on August 21, 2013 to solicit public input on the ESD. Responses to public comments were provided with the final ESD, signed in March 2014.

In accordance with the LUC RD, the Navy also coordinates with the Town of Bedford's Board of Health regarding the use of groundwater in the vicinity of NWIRP Bedford, on at least an annual basis.

7.0 CONCLUSIONS

This report demonstrates that the components of the selected remedial action for the SFTA have been implemented and are operating properly and successfully and are consistent with the provisions of CERCLA, Section 120(h)(3).

As described in Section 1, the purpose of the I-RACR is to demonstrate that all construction activities are complete, the RAOs are being met, the required institutional controls are in place, and the site is protective of human health and the environment. Similarly, the core criteria for an OPS Demonstration for a site where MNA is the primary remedial action include showing that (1) construction of the source control portion of the remedy is complete (or the source has been removed) in accordance with the approved design; and (2) natural attenuation is working.

Remedial action construction activities have previously been completed for the SFTA: the remedial action (MNA and LUCs) requires groundwater monitoring wells at the site, and the Navy had previously installed the necessary wells at the site and has been conducting semi-annual groundwater monitoring since 2002.

The selected remedial action for the SFTA satisfies the RAOs outlined in Section 2 through the use of MNA to reduce COC concentrations in groundwater, and through the use of LUCs to prevent the use of groundwater as a drinking water supply until remediation goals have been achieved. The LUCs have been implemented through the approved LUC RD (Navy, 2015) and the ongoing program of annual LUC inspections. The data set from the SFTA groundwater monitoring program shows that the TCE plume is stable or retreating, thereby satisfying the RAO for preventing the migration of COCs in groundwater. No residual source area has been identified on site.

The remedial action is effective and protective of human health and the environment. Results from the ongoing groundwater monitoring program indicate that natural attenuation of TCE in the bedrock groundwater is occurring, as evidenced by the following:

- TCE concentrations in bedrock groundwater have decreased substantially since 1993, and current data indicate that only three wells exceed the TCE cleanup goal of 5 µg/L.

- Results of MNA geochemical indicator parameters indicate that the groundwater conditions are generally favorable for the biological degradation of TCE.

- Graphical and statistical evaluations of the groundwater data set show a continuing trend of attenuating TCE concentrations over time. The observed decreases are statistically significant at a

99 percent confidence level. The residual TCE contamination observed is predicted to attenuate to the remediation goal within an acceptable timeframe.

The identified risks to human health are associated with the use of site groundwater as a drinking water supply. MNA will reduce COC concentrations to acceptable levels, consistent with federal and state standards for drinking water. During the interim, the implementation of LUCs at the SFTA is protective of human health and the environment because it:

- Prevents the use of SFTA groundwater as a drinking water supply until TCE concentrations in groundwater achieve the cleanup goal.

- Prevents the residential development of the SFTA area until it is demonstrated that soil and groundwater conditions allow for unlimited use and unrestricted exposure.

- Maintains the integrity of groundwater monitoring wells needed to support the remedial action.

The SFTA has been extensively investigated, and a remedy that is consistent with others implemented at NWIRP Bedford has been selected in consultation with USEPA and MassDEP, with opportunity for public input, in accordance with CERCLA. The selected remedial actions are being implemented as designed and include measures that prevent exposure, thereby eliminating any unacceptable risk to public health or the environment. Currently, the remedial actions (MNA/LTM and LUCs) are operating as designed, and the groundwater data indicate continued progress toward meeting the RAOs. The remedy being employed at the SFTA has a proven track record of success, and ongoing monitoring plus five-year reviews will ensure its continued effectiveness. The established LUCs are enforceable by the Navy and regulatory agencies, and future landowners will be required to comply with the LUCs, which will also be included in provisions of the deed and other property transfer documents, and thus will "run with the land".

REFERENCES

AGVIQ/CH2M HILL. 2015. "Performance Groundwater Monitoring Report, May 2015 – Fourth Quarter/Post-Injection Event, Site 3 Remedial Action, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. June.

Department Of Defense (DoD) and the United States Environmental Protection Agency (USEPA), 2005. DoD/EPA Joint Guidance on Streamlined Site Closeout and NPL Deletion Process For DoD Facilities. December.

Dames & Moore, 1990a. "Technical Memorandum, Remedial Investigation Findings, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." February.

Dames & Moore, 1990b. "Supplemental Investigation, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." July.

Dames & Moore, 1992. "Technical Memorandum of Remedial Investigations, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." August.

Gilbert, Richard O., 1987. "Statistical Methods for Environmental Pollution Monitoring." Indianapolis, IN.

H&S Environmental and Tetra Tech, 2012. "Sampling and Analysis Plan for Groundwater Monitoring at Site 3, Site 4, and the Southern Flight Test Area, 2012 – 2014, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. October.

H&S Environmental and Tetra Tech, 2013. "September 2013 Semi-Annual Monitoring Report for Southern Flight Test Area, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. December.

H&S Environmental and Tetra Tech, 2014. "Addendum #1, Sampling and Analysis Plan for Groundwater Monitoring at Site 3, Site 4, and the Southern Flight Test Area, 2012 – 2014, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. March.

Naval Energy and Environmental Support Activity (NEESA), 1988. "Initial Assessment Study of Naval Weapons Industrial Reserve Plant, Bedford, Mass.", NEESA 13-099, Port Hueneme, CA.

Resolution Consultants (Resolution), 2014. "Final Five-Year Review, Naval Weapons Industrial Reserve Plant (NWIRP), Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. September.

Resolution, 2015a. "Draft Groundwater Investigation for Emerging Contaminants, Site 3 and Southern Flight Test Area, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. May.

Resolution, 2015b. "Draft Groundwater Investigation for 1,4-Dioxane, Southern Flight Test Area, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. August.

Sovereign Consulting, Inc. (Sovereign), 2014. "Land Use Control (LUC) Annual Inspection for 2014, Former Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. November 21.

Sovereign, 2015. "April 2015 Semi-Annual Groundwater Monitoring Report, Southern Flight Test Area, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. August.

Tetra Tech, 2000. "Remedial Investigation Phase II Report, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." September.

Tetra Tech, 2013a. "Supplemental Groundwater and Soil Gas Sampling for Southern Flight Test Area, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. August.

Tetra Tech, 2013b. "Vapor Intrusion Evaluation for Southern Flight Test Area, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. November.

Tetra Tech, 2014. "Sampling and Analysis Plan for Groundwater Monitoring at Site 3, Site 4, and the Southern Flight Test Area, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts". Addendum #1. Prepared for the Naval Facilities Engineering Command, Mid-Atlantic. March.

U.S. Environmental Protection Agency (USEPA), 1989. "Statistical Analysis of Groundwater Monitoring at RCRA Facilities". Washington, D.C.

USEPA Office of Solid Waste and Emergency Response, 1996. "Guidance for Evaluation of Federal Agency Demonstrations that Remedial Actions are Operating Properly and Successfully Under CERCLA Section 120(h)(3), (Interim)." August.

U.S. Navy, 2010. "Record of Decision, Site 3 – Chlorinated Solvent Groundwater Plume, Naval Weapons Industrial Reserve Plant, Bedford, Massachusetts." September.

U.S. Navy, 2014. "Explanation of Significant Differences to the Record of Decision for Site 3 – Chlorinated Solvent Groundwater Plume, Naval Weapons Industrial Reserve Plant (NWIRP), Bedford, Massachusetts." March.

U.S. Navy, 2015. "Land Use Control Remedial Design for Site 3 – Chlorinated Solvent Groundwater Plume and Southern Flight Test Area, Naval Weapons Industrial Reserve Plant (NWIRP), Bedford, Massachusetts." Revision 1. January.

U.S. Navy and U.S. Air Force. 2008. Memorandum of Understanding between Commanding Officer, Naval Facilities Engineering Command, Mid-Atlantic and Commander, 66th Air Base Wing, subj: Ground Water Remediation at the Southern Flight Test Area, Naval Weapons Industrial Reserve Plant, Bedford. March.

TABLES

TABLE 1
SUMMARY OF ENVIRONMENTAL INVESTIGATIONS
SOUTHERN FLIGHT TEST AERA
NWIRP BEDFORD, MASSACHUSETTS

Activity/Event	Date
Operational period for the NWIRP Bedford Activity (owned by the U.S. Government [Navy] and operated by the Raytheon Company)	1950s to 2000
Preliminary Assessment (PA), formerly known as the Initial Assessment Study (IAS) (NEESA, 1988)	1986
Phase I Remedial Investigation (RI) (Dames & Moore, 1990a, 1992)	1988 to 1992
Phase I Supplemental Investigation identified chlorinated volatile organic compounds (CVOCs) in bedrock groundwater in the southern area of NWIRP Bedford, now referred to as the SFTA (Dames & Moore, 1990b)	1990
EPA placed NWIRP Bedford on the NPL	May 31, 1994
Supplemental Investigation (presented as Appendix K of the Phase II RI)	1998 to 2000
Phase II RI (Tetra Tech, 2000)	1992 to 2000
Navy and EPA signed a Federal Facilities Agreement (FFA), which directed the Navy to reach an agreement with the Air Force at the adjacent Hanscom Air Force Base (where the Air Force is operating a nearby groundwater remediation system) to remediate groundwater at the SFTA. The SFTA was not otherwise identified as an Area of Concern under the FFA.	February 2000 (effective date)
Semi-annual groundwater monitoring program at the SFTA	Fall 2002 to present
Navy and Air Force signed a Memorandum of Understanding (MOU) to ensure continued monitoring and information sharing regarding the SFTA and the Air Force's nearby groundwater cleanup efforts at Hanscom Air Force Base	August 2008
Navy and EPA signed the Site 3 ROD (OU-1)	September 2010
Full-scale operations for the Site 3 Remedial Action commenced	November 2012
Supplemental sampling event at the SFTA included the sampling of new groundwater wells and soil gas probes (Tetra Tech, 2013a)	February 2013
Explanation of Significant Differences (ESD) to the ROD for Site 3, which added the SFTA to OU-1	March 2014
Updated the Sampling and Analysis Plan (SAP) for Groundwater Monitoring at Site 3, Site 4, and the SFTA in order to incorporate MNA parameters into the SFTA program (Tetra Tech, 2014)	March 2014
Revised the Land Use Control Remedial Design (LUC RD), incorporating the SFTA into the Site 3 LUCs	January 2015
Conducted supplemental sampling of groundwater at the SFTA for perfluorinated compounds (PFCs) (Resolution, 2015a)	December 2014
Conducted supplemental sampling of groundwater at the SFTA for 1,4-dioxane (Resolution, 2015b)	May 2015

TABLE 2
HISTORICAL ANALYTICAL RESULTS FOR TCE AND DCE IN BEDROCK GROUNDWATER
SOUTHERN FLIGHT TEST AREA
NWIRP BEDFORD, MASSACHUSETTS

Location ID	Sample Date			TCE (µg/L)	cis-1,2-DCE (µg/L)	trans-1,2-DCE (µg/L)
				PAL = 5 µg/L	PAL = 70 µg/L	PAL = 90 or 100 µg/L[(1)]
MW-7B	Oct	1989		10 U	NS	NS
	Jan	1990		0.2 U	NS	NS
	Apr	1990		0.2 U	NS	NS
	Apr	1993		10 U	NS	NS
	Oct	1998		1 U	5 U	5 U
	Nov	2011		0.5 U	0.5 U	0.5 U
	Jun	2012		0.5 U	0.5 U	0.5 U
	Feb	2013		0.5 U	0.5 U	0.5 U
MW-8B	Jun	1989		**230**	NS	NS
	Nov	1989		**200**	NS	NS
	Jan	1990		**190**	NS	NS
	Apr	1990		**150**	NS	NS
	Apr	1993		**110**	NS	NS
	Sep	1998		**58.5**	**5.1**	5 U
	Nov	2002		**33**	**4**	1 U
	Apr	2003		**28.2**	**3.83**	1 U
	Jul	2003		**26.6**	**3.74**	1 U
	Feb	2004		**26.8**	**4.05**	1 U
	Jul	2004		**25.5**	**3.3**	1 U
	Feb	2005		**26.6 J**	**3.4 J**	1 UJ
	Aug	2005		**24.1 J**	**3.4 J**	1 UJ
	Apr	2006		**25.5**	**4.4**	0.51 U
	Aug	2006		**19.4**	**2.6**	1 U
	Apr	2007		**23**	**4.4**	1 U
	Aug	2007		**20.5**	**3.2 J**	1 U
	Mar	2008		**23**	**4.8**	1 U
	Aug	2008		**18**	**3.9**	1 UJ
	Mar	2009		**21**	**5**	1 U
	Sep	2009		**16**	**3**	1 U
	Mar	2010		**18**	**4**	1 U
	Sep	2010		**15**	**3**	1 U
	Mar	2011		**16**	**4**	1 U
	Nov	2011	AVG	**12**	**2.6**	0.5 U
	Jun	2012		**12**	**2.3**	0.5 U
	Nov	2012		**13**	**2.1**	1 U
	Feb	2013		**11.9**	**2.8**	0.5 U
	Sep	2013		**13**	**2.5**	1 U
	Mar	2014		**12**	**2.9**	1 U
	Sep	2014		**14**	**2.7**	1 U
	Apr	2015		**13**	**2.7**	1 U
MW-9B	Oct	1989		**9**	10 U	10 U
	Jan	1990		**6.2**	0.2 U	0.2 U
	Apr	1990		**4.7**	0.2 U	0.2 U
	Apr	1993		**4 J**	10 U	10 U

TABLE 2
HISTORICAL ANALYTICAL RESULTS FOR TCE AND DCE IN BEDROCK GROUNDWATER
SOUTHERN FLIGHT TEST AREA
NWIRP BEDFORD, MASSACHUSETTS

Location ID	Sample Date			TCE (µg/L)	cis-1,2-DCE (µg/L)	trans-1,2-DCE (µg/L)
				PAL = 5 µg/L	PAL = 70 µg/L	PAL = 90 or 100 µg/L[(1)]
MW-23R	Apr	1993		10 U	NS	NS
	Sep	1998		1 U	5 U	5 U
	Nov	2011		0.5 U	0.5 U	0.5 U
	Jun	2012		0.5 U	0.5 U	0.5 U
	Feb	2013		0.5 U	0.5 U	0.5 U
	Mar	2014		0.5 U	0.5 U	1 U
	Apr	2015		0.5 U	0.5 U	1 U
MW-24R	Apr	1993		**250**	NS	NS
	Sep	1998	AVG	**134**	**5.4**	**1.56 J**
	Nov	2002	AVG	**74.5**	**2**	1 U
	Apr	2003		**52.8**	**1.65**	1 U
	Jul	2003		**71.1**	**2.47**	1 U
	Feb	2004		**63**	**2.31**	1 U
	Jul	2004	AVG	**57.6 J**	**2.25**	**0.2 J**
	Feb	2005	AVG	**62 J**	**2 J**	**0.2 J**
	Aug	2005		**60.1 J**	**2.2 J**	1 UJ
	Apr	2006		**60.6**	**2.3**	0.51 U
	Aug	2006		**49.9**	**2**	1 U
	Apr	2007		**51.7**	1 U	1 U
	Aug	2007		**42.2**	**1.8 J**	1 U
	Mar	2008	AVG	**48.5**	**2.35**	1 U
	Aug	2008		**38**	**1.7**	1 UJ
	Mar	2009	AVG	**51**	**2**	1 U
	Sep	2009		**42**	**2**	1 U
	Mar	2010		**44**	**2**	1 U
	Sep	2010		**37**	**2**	1 U
	Mar	2011		**37**	**2**	1 U
	Nov	2011		**32**	**1.5**	0.5 U
	Jun	2012	AVG	**38**	**1.4**	0.5 U
	Nov	2012	AVG	**34**	**1.5**	1 U
	Feb	2013	AVG	**38.5**	**1.6**	0.5 U
	Sep	2013	AVG	**35.5**	**1.4**	1 U
	Mar	2014	AVG	**34.5**	**1.4**	1 U
	Sep	2014	AVG	**39**	**1.6**	1 U
	Apr	2015	AVG	**35**	**1.5**	1 U

TABLE 2
HISTORICAL ANALYTICAL RESULTS FOR TCE AND DCE IN BEDROCK GROUNDWATER
SOUTHERN FLIGHT TEST AREA
NWIRP BEDFORD, MASSACHUSETTS

Location ID	Sample Date			TCE (µg/L) PAL = 5 µg/L	cis-1,2-DCE (µg/L) PAL = 70 µg/L	trans-1,2-DCE (µg/L) PAL = 90 or 100 µg/L[1]
MW-25R	Apr	1993		**130**	NS	NS
	Sep	1998		**1.5**	5 U	5 U
	Nov	2002		**0.80 J**	1 U	1 U
	Apr	2003	AVG	**0.80 J**	1 U	1 U
	Jul	2003		**1**	1 U	1 U
	Feb	2004		**0.49 J**	1 U	1 U
	Jul	2004		**0.50 J**	1 U	1 U
	Feb	2005		**0.60 J**	1 UJ	1 UJ
	Aug	2005		**0.88 J**	1 UJ	1 UJ
	Apr	2006		**0.51 J**	0.7 U	0.51 U
	Aug	2006		0.74 U	1 U	1 U
	Apr	2007		1 U	1 U	1 U
	Aug	2007		1 U	1 UJ	1 U
	Mar	2008		**0.36 J**	1 U	1 U
	Aug	2008		**0.95 J**	1 U	1 UJ
	Mar	2009		**0.6 J**	1 U	1 U
	Sep	2009		**0.5 J**	1 U	1 U
	Mar	2010		1 U	1 U	1 U
	Sep	2010		0.4 J	1 U	1 U
	Mar	2011		1 U	1 U	1 U
	Nov	2011		**0.46 J**	0.5 U	0.5 U
	Jun	2012		0.5 U	0.5 U	0.5 U
	Nov	2012		**0.63 J**	0.5 U	1 U
	Feb	2013		0.5 U	0.5 U	0.5 U
	Sep	2013		0.5 U	0.5 U	1 U
	Mar	2014		0.5 U	0.5 U	1 U
	Sep	2014		0.5 U	0.5 U	1 U
	Apr	2015		0.5 U	0.5 U	1 U
MW-84R	Feb	2013		**7.4**	**4.4**	0.5 U
	Mar	2014		**6.6**	**3.3**	1 U
	Apr	2015		**6.1**	**2.6**	1 U
MW-85R	Feb	2013		**1.8**	**0.83 J**	0.5 U
	Mar	2014		**3.5**	0.5 U	1 U
	Apr	2015		**2.9**	0.5 U	1 U
MW-86R	Feb	2013		**0.76**	0.5 U	0.5 U

(1) The MCP GW-2 criterion (90 ug/L) is lower than GW-1 criterion (100 ug/L); thus the GW-2 criterion is used to develop the PAL for groundwater samples collected from wells where the depth to water is less than or equal to 15 feet. The GW-1 criterion is used for the other wells.

Bold values indicate a detected concentration.
Highlighted values indicate concentrations that exceed the PAL.
AVG = average
PAL = project action limit (per the Sampling and Analysis Plan)
DUP = duplicate sample
DCE = dichloroethene
TCE = trichloroethene
NS = Not sampled
J = estimated value
U = non-detect value
µg/L = micrograms per liter

TABLE 3
RESULTS FOR MNA INDICATOR PARAMETERS IN BEDROCK GROUNDWATER (FEBRUARY 2013)
SOUTHERN FLIGHT TEST AREA
NWIRP BEDFORD, MASSACHUSETTS

ANALYSIS METHOD	MNA PARAMETER	units	BED-GW-MW-7B-0213	BED-GW-MW-8B-0213	BED-GW-MW23R-0213	BED-GW-MW-24R-0213	BED-GW-DUP01-022013[1]	BED-GW-MW-24R-AVG	BED-GW-MW-25R-02-13	BED-GW-MW-84R-0213	BED-GW-MW-85R-0213	BED-GW-MW-86R-0213
						ORIG	DUP	AVG				
Bedrock Monitoring Wells												
field test	Dissolved Oxygen (DO)	mg/L	0.48	0.29	1.71	0.22	NA	NA	2.78	0.40	0.26	0.57
field test	Oxidation Reduction Potential (ORP)	mV	-102.1	183.8	130.7	60.8	NA	NA	94.5	-105.2	79.2	-129.4
field test	pH	S.U.	7.41	6.77	6.2	6.45	NA	NA	6.29	6.64	7.18	6.88
6010C	Iron (total)	mg/L	NA	0.025 U	0.166 J	0.849 J	0.854 J	0.852 J	NA	0.164 J	0.0491 J	0.121 J
field kit	Iron (II)	mg/L	NA	0.03 U	0.03 U	0.47	0.4	0.435	NA	0.1	0.03 U	0.13
	ratio of Fe(II) to Fe(total)	--	--	--	--	55%	47%	51%	--	61%	--	100%
6010C	Manganese (total)	mg/L	NA	0.0605 J	0.178 J	1.210 J	1.250 J	1.230 J	NA	0.337 J	0.0316 J	0.280 J
9056	Chloride	mg/L	NA	180	100	280	270	275	NA	120	100	120
9056	Nitrate (as N)	mg/L	NA	0.359	1.1	0.05 U	0.05 U	0.05 U	NA	0.401	0.332	0.249
9056	Nitrite (as N)	mg/L	NA	0.075 U	0.075 U	0.075 U	0.075 U	0.075 U	NA	0.075 U	0.075 U	0.075 U
9056	Sulfate	mg/L	NA	28 J	35 J	43 J	43 J	43 J	NA	32 J	15 J	30 J
SM4500	Sulfide	mg/L	NA	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	NA	0.5 U	0.5 U	0.5 U
9060	Dissolved Organic Carbon	mg/L	NA	1.5	1	2.7	2.1	2.4	NA	10.1	4.1	1.1
RSK175	Methane	ug/L	NA	2.5 U	2.5 U	8.3	10.8	9.6	NA	2.5 U	2.5 U	2.5 U
RSK175	Ethene	ug/L	NA	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	NA	2.5 U	2.5 U	2.5 U
RSK175	Ethane	ug/L	NA	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	NA	2.5 U	2.5 U	2.5 U
SM2320 B	Alkalinity	mg/L	NA	88	82	65	65	65	NA	110	67	69

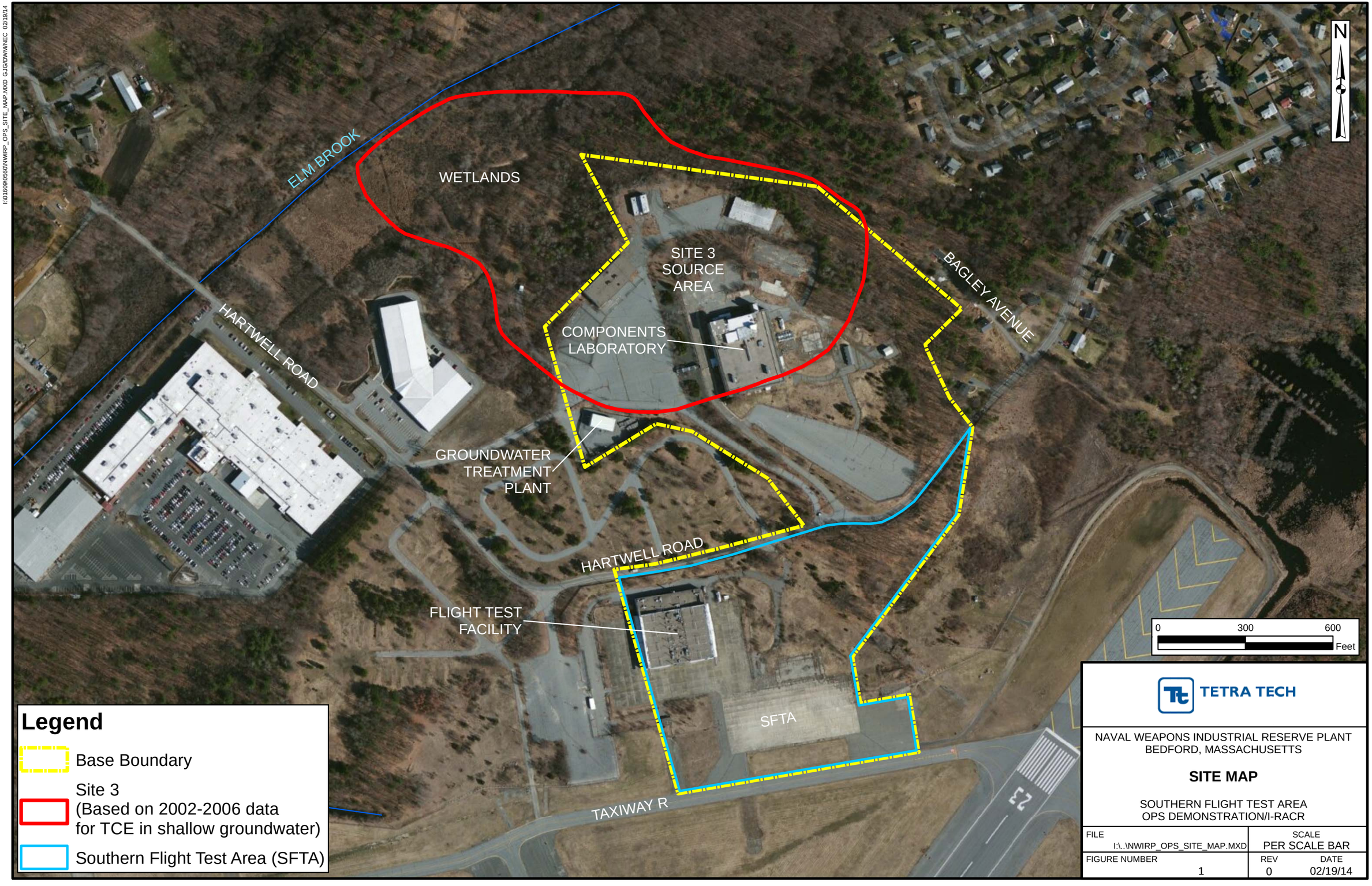
gray shaded = detected

NA = Not Analyzed, AVG = average of original and duplicate sample, U = not detected above cited concentration, J = estimated

(1) BED-GW-DUP01-022013 is the duplicate pair of MW-24R

FIGURES

I:\01609\0560\NWIRP_OPS_SITE_MAP.MXD GJG/DWM/NEC 02/19/14



Legend

- Base Boundary
- Site 3 (Based on 2002-2006 data for TCE in shallow groundwater)
- Southern Flight Test Area (SFTA)

TETRA TECH

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BEDFORD, MASSACHUSETTS

SITE MAP

SOUTHERN FLIGHT TEST AREA
OPS DEMONSTRATION/I-RACR

FILE	SCALE
I:\..\NWIRP_OPS_SITE_MAP.MXD	PER SCALE BAR
FIGURE NUMBER: 1	REV: 0 / DATE: 02/19/14

I:\01609\0560\NWIRP_OPS_COC_BR.MXD GJG/DWM/NEC 02/19/14

HARTWELL ROAD

TAXIWAY R

MW-23R
Non-detect

MW-7B
Non-detect

MW-85R
1.8 UG/L

MW-84R
7.4 UG/L

MW-24R
38.4 UG/L

MW-25R
Non-detect

MW-86R
0.76 J UG/L

MW-8B
11.9 UG/L

N

0 130 260
Feet

Legend

- Bedrock Groundwater Well
- Southern Flight Test Area (SFTA)
- NWIRP Boundary

TCE data from February 2013 sampling event.

TETRA TECH

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BEDFORD, MASSACHUSETTS

EXTENT OF TCE IN BEDROCK GROUNDWATER, FEBRUARY 2013

SOUTHERN FLIGHT TEST AREA
OPS DEMONSTRATION/I-RACR

FILE	SCALE
I:\..\NWIRP_OPS_COC_BR.MXD	PER SCALE BAR
FIGURE NUMBER 2	REV 0 / DATE 02/19/14

I:\016090560\NWIRP_ROD_LAND_USE.MXD GJG/DWM/NEC 05/02/14

ELM BROOK

HARTWELL ROAD

BAGLEY AVENUE

HARTWELL ROAD

TAXIWAY R

23

N

0 300 600
Feet

Legend

- Site 3 LUC Boundary
- SFTA LUC Boundary
- NWIRP Boundary

TETRA TECH

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BEDFORD, MASSACHUSETTS

LUC BOUNDARIES

SOUTHERN FLIGHT TEST AREA
OPS DEMONSTRATION/I-RACR

FILE	SCALE
I:\...\NWIRP_ROD_LAND_USE.MXD	PER SCALE BAR
FIGURE NUMBER	REV / DATE
3	0 / 05/02/14

I:\01609\0560\NWIRP_OPS_SFTA_BED_CONT_092013.MXD DWM/NEC 02/19/14

N

HARTWELL ROAD

MC11-3
(Former)

MC11-4
(Former)

MW-23S
MW-23R
136.74

MW-7S
(Former)

MW-7B
126.79

Flight
Test
Facility

MW-24S
MW-24R
122.91

MW-85R

MC11-1
(Former)

MC11-2
(Former)

MW-84R

MW-25S
MW-25R
119.57

Edge of
Concrete
Apron

MW-9S
MW-9B
(Former)

MW-8S
MW-8B
120.36

MW-86R

TAXIWAY R

136
134
132
130
128
126
124
122
120

Legend

122.13 Bedrock Groundwater Elevation (feet, NAVD, 1988)

Existing Groundwater Wells

Former Wells

Bedrock Groundwater Flow Direction

Interpreted Bedrock Groundwater Contour Line

NWIRP Boundary

Existing Buildings

Former Buildings

0 50 100 200 Feet

TETRA TECH

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BEDFORD, MASSACHUSETTS

MONITORING WELL NETWORK AND BEDROCK GROUNDWATER CONTOURS - SEPTEMBER 23, 2013

SOUTHERN FLIGHT TEST AREA
OPS DEMONSTRATION/I-RACR

FILE	I:\..\NWIRP_OPS_SFTA_BED_CONT_092013.MXD	SCALE	PER SCALE BAR
FIGURE NUMBER	4	REV	0
		DATE	02/19/14